General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

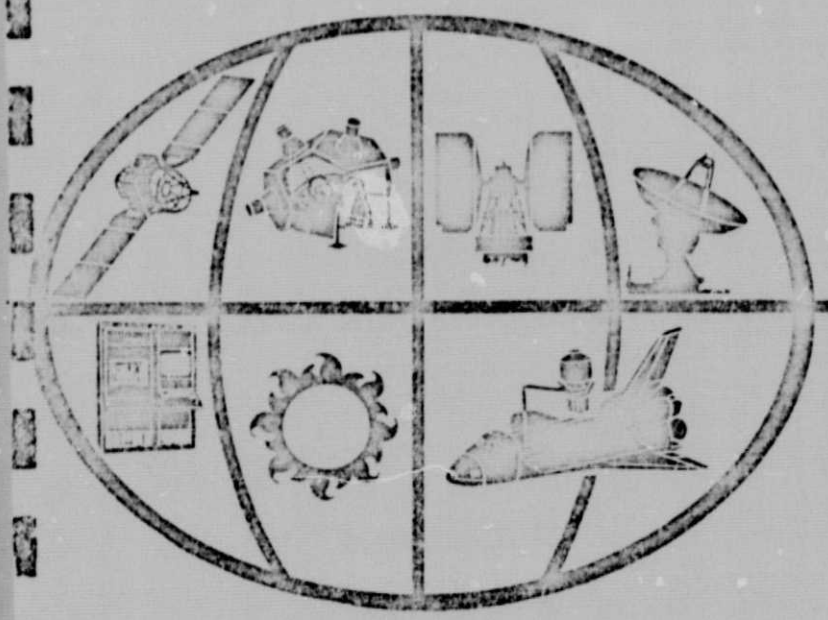
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

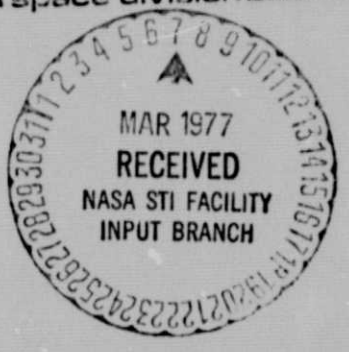
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

EARTH VIEWING APPLICATIONS LABORATORY (EVAL)

INSTRUMENT CATALOG



space division



GENERAL ELECTRIC

EARTH VIEWING APPLICATIONS LABORATORY (EVAL)

INSTRUMENT CATALOG

25 MAY, 1976

GENERAL ELECTRIC
SPACE DIVISION
VALLEY FORGE, PA.

PREFACE

This document contains a comprehensive description of 87 instruments used in Earth Observation, with an additional 51 instruments containing references to programs and their major functions.

These instruments were selected from such sources as:

- Earth Observation Flight Programs (e.g., Numbus, Landsat, Skylab, etc.)
- Operational Satellite Improvement Programs (OSIP)
- Advanced Application Flight Experiment Program (AAFE)
- Shuttle Experiment Definition Program (SHUTTLE)
- Earth Observation Aircraft Program (A/C)
- Support Research and Technology Program (SR&T)

The time period covered for these instruments is from the late 1960's to the early 1980's.

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage	Instantaneous Angular Field of View
				#	Location	(Deg)	(Deg)
Multispectral Photographic Facility (S-190A)	Skylab	High Resolution Multispectral Imagery	Mapping Camera	6	.4-.85 μm	20° x 20°	26 μrad
Earth Terrain Camera (S-190B)	Skylab	High Resolution Mapping	Mapping Camera	1	.4-.85 μm	15° x 15°	14-55 μrad
Optical Bar Panoramic Camera (S-163)	Apollo	High Resolution Mapping	Panoramic Scanning Film Camera	1	.4-.85 μm	108° Cross-Track 11° Along-Track	12 μ rad
Multispectral Scanner (MSS)	Landsat	Multispectral Imagery	Scanning Spectral Radiometer	4 1	0.5-1.1 μm 10.5-12.5 μm	11.6°	85.7 μrad 257 μrad
Multispectral Scanner (S-192)	Skylab	Multispectral Imagery	Scanning Spectral Radiometer	9 3 1	.41-1.19 μm 1.2-2.35 μm 10.3-12.5 μm	11.0°	162 μrad
Return Beam Vidicon (RBV)	Landsat	Multispectral Imagery	Image Tube Spectral Radiometer	3	.48-.83 μm	11.6° x 11.6°	90 μrad
High Resolution IR Radiometer (HRIRS)	Nimbus F	Vertical Temp Profile & H_2O Distribution	Scanning Spectral Radiometer	17	0.7-15 μm	72°	1.5°
IR Temperature Profile Radiometer (ITPR)	Nimbus 6	Vertical Temp Profile	Filter Spectrometer	7	3.8-15 μm	76°	1.5°
Automatic Picture Taking (APT)	Nimbus 1, 2	Local Cloud Cover Images	Image Tube Mapper	1	0.5-0.75 μm	77°	0.25°
Advanced Vidicon Camera (AVCS)	Nimbus 1, 2	High Resolution Cloud Images	Image Tube Mapper	3	0.5-0.75 μm	107°	0.10°
High Resolution IR Radiometer (HRIR)	Nimbus 3	Day/Night Cloud Cover	Scanning Imaging Radiometer	2	0.7-1.3 μm 3.4-4.2 μm	Horizon-to-Horizon	0.4°
Image Dissector Camera (IDCS)	Nimbus 3, 4	Day Cloud Cover	Image Tube Radiometer	1	0.5-0.75 μm	98° x 74°	0.1°
Temperature/ Humidity IR Radiometer (THIR)	Nimbus 4, 5, F, G	Cloud Cover, Water Vapor Mapping	Scanning Imaging Radiometer	2	6.5-7.5 μm 10.5-12.5 μm	Horizon-to-Horizon	1.2° 0.4°

...ur ...ew	Look Angle Limitations	Size			Shape	# Of Packages	Weight	Cooling Requirements	Power Requirements			Stabilization Requirements				Type of Output
								Cryogene	Volt	Avg. Power	Peak Pwr.	Slew. & Settling Time	Rate Stability	Ptg. Accuracy	Stab. Amp	
	(Deg)	(CM)	(CM)	(CM)			(KG)			(Watts)	(Watts)	Deg/Sec	Deg/Sec	(Deg)	(Sec)	
	NADIR Viewing	46 31	65 46	72 46		2	109 34	None		200				0.6	3	
1	NADIR Viewing	70	36	27	Rect	1	36	None	115 VAC 400 Hz, +28 VDC					0.5	3	
	NADIR Viewing	152	65	74	Rect	1	185	None	115 VAC 400 Hz, 27.5 VDC	40 234	340					
	NADIR Viewing	117	60	45	Rect	1	64	100°K		65						PCM
	NADIR Viewing	142	92	57	Rect	1	159	100°K		250						PCM
	NADIR Viewing	67	67	32			86	None		144	168					3-Serial Analog Video
	NADIR Viewing	52	26	45	Rect	1	33	120°K	28 VDC	23						Digital
	NADIR Viewing	50	37	30	Rect	1 (optics) 1 (Elect)	9 9	None		14						Digital
	NADIR Viewing	32	15	15	Cyl.	1	12	None		40						Video
	NADIR Viewing	30	47	20	Rect	1	60	None		27						Video
	NADIR Viewing	42	22	15	Rect	1	7	200°K		14						Video
	NADIR Viewing	40	17	15	Rect	1	8	None		13						Video
	NADIR Viewing	40 15	17 15	17 15	Rect	2	9	None		9						Video

irements		Data						
uracy	Stab. Amp (Sec)	Type Of Output	Rate (BPS)	Format	Storage (Bits)	Accuracy (Bits/Wd)	Frame Rate (Fr/Sec)	Special Considerations
	3		N/A				64/Sec	Aperture Control Adjustable from f/28 to f/16 in 1/2-Stop Increments; 6" Focal Length
	3		N/A				0-25 Fr/Min	f/4 Relative Aperture 18" Focal Length
			N/A				4.7 to 8.9 Sec/Frame	f/3.5 Relative Aperture 24" Focal Length
		PCM	15×10^6	1 Minor Frame Ea. 6x6 Pix.		6 Bits/Word	7	
		PCM	9.7×10^5			8 Bits/Word	94.8	Length of Sensor Scan Rotation Period Not Constant Which Results In Either Unequal Frame Lengths or Unequal Words/Frame Complicates Processing
		3-Serial Analog Video	3.2×10^6 P. Chan.				25 Sec. Cycle Time	
		Digital	3.4×10^3	NIMBUS HDRSS			1/4 Sec.	
		Digital	2.5×10^3	10 Bit Word			1/80 Sec.	
		Video					200 Sec/Fr.	
		Video					4 Sec/Fr.	
		Video		RTTS			1.25 Sec/Line	
		Video	2.4×10^3	RTTS			1/200 Sec	
		Video	360	RTTS			1.2 Sec/Line	

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage (Deg)	Instantaneous Angular Field of View (Deg)	
				#	Location			
Surface Comp. Mapping Radiometer (SCMR)	Nimbus 5	Identification of Surface Minerals	Filter Spectrometer	3	.8-1.1 μm 8.3-9.2 μm 10.5-11.3 μm	Horizon-to-Horizon	0.4°	
Earth Radiation Budget (ERB)	Nimbus F, G	Planetary Heat Budget; Solar Radiation & Earth Flux	Fixed and Scanning Radiometers	22 (10 Solar) (12 Earth)	0.2-5.0 μm	±55° Cross-Track ±65° Along-Track	5x.25° (Scan Ch.) 29° (Solar Ch.) 133° (Fixed Earth)	
Medium Resolution IR Radiometer (MRIR)	Nimbus 2, 3	Vertical Temp. Profile, Heat Balance	Imaging Spectrometer	5	0.5-29 μm	Horizon-To-Horizon	2.7°	
Infrared Spectrometer (S-191)	Skylab	Atmospheric Calibration Data	Spectral Radiometer	90	.42-2.5 μm 6.6-16.0 μm	N/A	1 mrad	
Limb Radiance Inversion Radiometer (LRIR)	Nimbus F	Stratospheric Profiles of Temp, H_2O and O_3	Scanning Spectral Radiometer	4	8.7-25 μm	20°	0.3° x 0.03°	
Backscatter UV Spectrometer (BUV)	Nimbus 4	Spatial Distribution of Ozone	Grating Spectrometer	13	2500-3900°A	12°	12°	
Filter Wedge Spectrometer (FWS)	Nimbus 4	Vertical Distr. & Temp. Profile of H_2O and CO_2	Filter Spectrometer	320	1.2-2.4 μm 3.2-6.4 μm	2.6°	2.6°	
IR Interferometer Spectrometer (IRIS)	Nimbus 3, 4	Vertical Temp. and H_2O Profile	Michelson Interferometer	N/A	5-25 μm	8° (Nimbus 3) 5° (Nimbus 4)	8° (Nimbus 3) 5° (Nimbus 4)	
Selective Chopper Radiometer (SCR)	Nimbus 5	Vertical Temp. Profile, Dist. of H_2O, Ice Part, Density in Clouds	Gas Cell Filter Spectrometer	16	2-100 μm	1.5°	1.5°	
Satellite IR Spectrometer (SIRS)	Nimbus 4	Vertical Temp. Profile Distr. of ATM. Gases	Grating Spectrometer	14	11-35 μm	±35°	12°	
Pressure Modulated Radiometer (PMR)	Nimbus F	Vertical Temp. Profile to 85 Km	Pressure Broadening Spectrometer	2	15 μm	15°	4° x 20°	
L-Band Radiometer (S-194)	Skylab	Measure Surface Brightness Temp.	Microwave Radiometer (Passive)	1	1.4-1.427 GHz	15°	15°	
Radiometer/ Scatterometer/ Altimeter (S-193)	Skylab	Temperature Distribution for Oceanology	Microwave Radiometer/ Scatterometer	1	13.9 GHz	48°	27 mrad	

2

	Total Angular Coverage (Deg)	Instantaneous Angular Field of View (Deg)	Look Angle Limitations (Deg)	Size (CM)	(CM)	(CM)	Shape	# of Pkgs	Weight (Kg)	Cooling Requirements Cryogens	Power Requirements Volt	Avg. Pwr. (Watts)	Peak P (Wat
n m	Horizon-to-Horizon	0.4°	NADIR View	52 27	22 30	40 12	[illegible]	2 Elect.	27	100° K		11	77
	±55° Cross-Track ±65° Along-Track	5x.25° (Scan Ch.) 29° (Solar Ch.) 133° (Fixed Earth)	NADIR and Solar View	35	32	47	Rect	1	26	None		25	
	Horizon-To-Horizon	2.7°	NADIR View	32	15	17	Rect	2	7			7	
m	N/A	1 mrad	Earth Viewing	0.3m^3	-	-	-	-	136	100° K		10	
	20°	0.3° x 0.03°	Horizon Viewing	22 35 15	22 35 15	60 45 20	Cylind Rect	1 2	50	65° K		28	
A	12°	12°	Earth Viewing	55 15	20 15	15 15	Rect Rect	2	16		-24.5 VDC	13	
	2.6°	2.6°	Earth Viewing	32	16	15	Rect	1	16	170° K		20	
	8° (Nimbus 3) 5° (Nimbus 4)	8° (Nimbus 3) 5° (Nimbus 4)	Earth Viewing	37	32	20	Rect	3	15	250° K		25	
	1.5°	1.5°	Earth Viewing	42	20	30	Rect	2	14	None		15	3
	±35°	12°	NADIR Viewing	52	30	30	Cylind	5	32	None		24	
	15°	4° x 20°	NADIR Viewing	22	17	22	Rect	1	11	None		5	1
	15°	15°	Earth Viewing	.25m^3	-	-	-	-	17	NA		13	
	49°	27 mrad	NADIR View	0.65m^3	-	-	-	-	35	NA		153	

ngle ions	Size (CM)	(CM)	(CM)	Shape	# of Pkgs	Weight (Kg)	Cooling Requirements Cryogene	Power Requirements Volt	Avg. Pwr. (Watts)	Peak Pwr. (Watts)	Stabilization Requirements Slew. and Settling Time (Deg, Sec)	Rate Stability (Deg/Sec)	Ptg. Accuracy (Deg)	Stab. Amp (Sec)	
	52 22	22 30	40 12	Rect Rect	2 2 ea-310 Elect.	27	100°K		11	77					Vid
nd ow	35	32	47	Rect	1	26	None		25						Digi
	32	15	17	Rect	2	7			7						
	0.3m^3	-	-	-	-	136	100°K		10						FCH
	22 35 15	22 35 15	60 45 20	Cylind Rect	1 2	50	65°K		28						Digit
	55 15	20 15	15 15	Rect Rect	2	16		-24.5 VDC	13						Digit
	32	16	15	Rect	1	16	170°K		20						Digit
	37	32	20	Rect	3	15	250°K		25						Digita
	42	20	30	Rect	2	14	None		15	35					Digita
	52	30	30	Cylind	5	32	None		24						Digita
	22	17	22	Rect	1	11	None		5	15					Digital
	.25m^3	-	-	-	-	17	NA		10						FCM
	0.65m^3	-	-	-	-	95	NA		153						ACM Split Phase

2 B

bilization Requirements				Data						Special Considerations
l- Rate Stability (Deg/Sec)	Ptg. Accuracy (Deg)	Stab. Amp (Sec)	Type of Output	Rate (Bps)	Format	Storage (Bits)	Accuracy (Bits/Wd)	Frame Rate (Fr/Sec)		
			Video	50×10^3	Analog			10 Lines/sec		10 min. Duty Cycle/Orbit
			Digital	50	Nimbus VIP		10 Bit/ Word			
				2×10^3	Nimbus VIP			8/sec		
			PCM	5.47×10^4			10 Bit/ Word	46.8 msec/Frame		Data taken only when Astronaut Highlights a Particular Area and Depresses Data Button.
			Digital	4×10^3	HDRSS					20 Sec. Horizon Acquisition 4 Sec. Horizon Scan.
			Digital	60			10 Bit/ Word	1/32 Sec.		
			Digital	220			10 Bit/ Word	1/16 Sec.		
			Digital	3.9×10^3	Nimbus		12 Bit/ Word	1/16 Sec.		
			Digital	4×10^3	Nimbus		10 Bit/ Word			
			Digital	250	Nimbus		10 Bit/ Word	1/2 Sec.		
			Digital	400	Nimbus			NA		
			PCM	180			10 Bit/ Word	1 Frame/Sec.		Two Data Cycles -34.6 min and 4.8 min Depending on Orbit.
			PCM Split Phase	5.33×10^3 10×10^3 (Alt)			10 Bit/ Word	2.665 Fr/Sec 1.04 Sec/Fr (Alt)		Large No. of Modes with Different Timing Results in Asynchronism between Data Acquisition and Telemetry Format.

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage	Instantaneous Angular Field of View
				#	Location	(Deg)	(Deg)
Electrically Scanning Microwave Radiometer (ESMR-F)	Nimbus F	Sea Ice Cover; H_2O Content of Clouds	Polarized Scanning Microwave Rad. (RF Diode)	2	37 GHz 5 GHz	74°	1.1° (37 GHz) 7.7° (5GHz)
Electrically Scanning Microwave Radiometer (ESMR)	Nimbus 5	Thermal Image of Ocean	Scanning Microwave Radiometer (RF Diode)	1	19.35 GHz	50°	1.5°
Tropical Winds Energy Conv. Ref. Level Exp. (TWERLE)	Nimbus F	Large Scale Atm. Motions; conversion of Potential to Kinetic Energy	RF Receiver, Balloon Transmitter (RF Diode)	8	401 MHz	NA	NA
Microwave Spectrometer (NEMS)	Nimbus 5	Vertical Temp. Profile Using O_2 Line, H_2O Distr.	Microwave Radiometer Spectrometer (RF Diode)	5	20-60 GHz	10°	10°
Scanning Microwave Spectrometer (SCAMS)	Nimbus F	Vertical Temp. Profile Using O_2 Line, H_2O Distr.	Scanning Spectral Microwave Radiometer	5	20-60 GHz	86°	7.5°
HF Bistatic Radar (HFBR)	Aircraft Flight					60°	
Large Format Camera (LFC)	Under Develop	High Resolution, Large Area Coverage Imagery, Stereo	Framing Mapping Camera	1	0.5-0.85 μm	40° Cross-Track 80° Along-Track	30 μrad
Thematic Mapper (TM)	Under Develop	High Resolution Multispectral Imagery	Scanning Spectral Radiometer	4 1 1 1	.5-1.1 μm 1.55-1.75 μm 2.1-2.35 μm 10.1-12.6 μm	14° Azimuth 2° Elevation	.0017° .0058°
Coastal Zone Color Scanner (CZCS)	Nimbus G	Ocean & Coastal Zone Water Color Temp., Map Chlorophyll, Sediment	Scanned Spectral Radiometer	6	0.4-0.8 μm 10.5-12.5 μm	±40° Azimuth 1.0° Elev.	0.05°
Advanced Very High Resolution Radiometer (AVHRR)	Under Develop	Sea Surface Temperature	Scanning Spectral Radiometer	5	0.7-12 μm	Horizon-to-Horizon	0.115° to 0.173°
Hadamaard Imagery Spectrometer (HADIS)	AAFE	Atmospheric IR Images for Meteorological Application	Hadamaard Spectrometer	1	8-16 μm	5°	5°
Measurement of Air Pollution from Satellite (MAPS)	Nimbus G	Global Distrib. of CO, SO_2, CH_4, NH_3	Gas Filter Radiometer	3	3-10 μm	7°	7°
Vertical Sounder	Under Develop	Vertical Temp. Distribution	Spectral Radiometer	14	3.7-30 μm	81°	1.125°

ngular w	Look Angle Limitations (Deg)	Size (CM)	(CM)	(CM)	Shape	# of Pkgs	Weight (Kg)	Cooling Requirements Cryogens	Power Requirements Volt	Avg. Pwr. (Watts)	Peak Pwr. (Watts)	Stabilization Requirements Slew and Settling Time (Deg. Sec)	Rate Stability (Deg/Sec	Pnt Accur (Deg
	NADIR View	90 90	90 90	12 25	Rect Rect	1	82	None		50				
	NADIR View	90	90	15	Rect	1	30	None		42				
						2	16	None		38				
	NADIR View	32	50	47	Rect	3	32	220°K		32	45			
	NADIR View	2 on 4/4 1 on 4/0			Nimbus Modules	3	32	None		37	50			
	Earth Viewing	5m Whip Antenna 0.1m^3 Electronics					3			100				±20°
	NADIR Viewing	81 15 30	61 43 43	117 51 69	Rect	3	136 11 34	NA		180				0.5
	±20° Off NADIR View	116	93	60	Rect	1	180	100°K Radiative	28 VDC	100				0.1
	NADIR Viewing	67	42	25	Rect	1	27	100°K		25				0.05
	NADIR View	4	6	12	Rect	1	23	100°K	28 VDC	25				
	NADIR	150	25	25	Rect	1	110	100°K		30				0.5°
	No Sunview NADIR Viewing	32 37	32 37	20 50	Rect Cyl.	3	43			67				0.3
	NADIR Viewing	60	37	37	Cyl.	1	20			30				

Stabilization Requirements				Data						Special Considerations
and Settling Time	Rate Stability	Ptg. Accuracy	Stab. Amp	Type of Output	Rate	Format	Storage	Accuracy	Frame Rate	
Deg, Sec)	(Deg/Sec	(Deg)	(Sec)		(Bps)		(Bits)	(Bits/Wd)	(Fr/Sec)	
				Digital	700	Nimbus 10 Bit Word		10	0.187	Large Planar Antenna
				Digital	400	Nimbus 10 Bit Word		10	0.187	Large Planar Array Deployed Outside the Vehicle
				Digital	500	Nimbus		10	NA	
					800	Nimbus VIP				No Metallic Objects Below Horns
				Digital	200	Nimbus 10 Bit Word		10	1/16 Sec	No Metallic Objects Below Horns
		±20°			200				10-45 Sec/Fr	20 Each, 20 Minute Data Takes
		0.5	3		NA					f/0 Relative Aperture 12" Focal Length
		0.1	0	Digital 7 Bits	120×10^6			7	45 msec/ Line	
		0.05	18	Digital	4×10^6				7.8 Lines Per Sec.	Tape Recorder Required
				Digital		8 Bits				
		0.5°			10×10^3					
		0.3	360	Digital	640					
					TBD				8 Sec/Scan	

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage	Instan
				#	Location	(Deg)	
Stratospheric & Mesospheric Sounder (SAMS)	NIMBUS G	Stratospheric Profiles of H_2O, N_2O, CH_4, CO, NO_2, NO, O_3	Pressure Broadening Spectral Radiometer	9	4.5 to 70 μm	6° Across Horizon 40° Azimuth	2° x
Stratospheric Aerosol Measurement (SAM II)	NIMBUS G	Stratospheric Aerosols	Spectral Radiometer	3	0.37 to 1 μm	Solar Occultation	0.010°
Solar Backscatter UV & Total Ozone Mapping Spectrometer (SBUV/TOMS)	NIMBUS G	Vertical Profile & Total Burden of O_3, Solar Irradiance	Spectral Photometer	8	.012-0.4 μm	90° 105°	3° x 3° 11° x 1
Lower Atm. Comp. & Temperature Experiment (LACATE)	NIMBUS G	Stratospheric Profiles of O_3, NO_2, H_2O, HNO_3, N_2O, CH_4, Aerosols & Temp	Scanning Spectral Radiometer	10	6.1-17.5 μm	+6°, -5° Elev. +45° Azimuth	.014° x .028° x .057° x
Correlation Inter. Meas. of Atm. Trace Species (CIMATS)	Under Develop	Measure CO, CH_4, N_2O, NH_3, O_3, SO_2, H_2O	Correlation Interferometer	5 5	2-2.4 μm 4-9 μm	7° or 2°	7° or 2
Aerosol Physical Properties Instrument (APP)	Under Develop	Stratospheric Profiles of Aerosols	Spectral Photometer	6	0.31-0.70 μm	2°	0.023°
Fraunhofer Line Discriminator (FLD)	Under Develop	Daytime Mapping of Luminescence	Photometer	6	3950-7000°A	10°	1°
Shuttle Imaging Microwave Systems (SIMS)	Shuttle	Measure Thermal Emissions from Earth Surface & Atmosphere	Passive Microwave Radiometer	11	0.61-118.7 GHz	60° Cross-Track 17° Along-Track	.09° - Functi Freque
Synthetic Aperture Radar (SAR)	Shuttle	High Resolution Microwave Imaging Soil Moisture Measurement	Active Imaging Microwave	2	9.0 GHz 1.04 GHz	±5°	
Synthetic Aperture Radar (SAR)	Seasat	All Weather Day/Night Ocean Physics Analyt. Senson	Active Imaging Microwave	2	9.3-9.5 GHz 1.7 GHz	10° x 1.2°	0.6° x 1.5° x
Multichannel Ocean Color Scanner (MOCS)	Under Develop	Spatial Distribution of Ocean Color	Scanning Spectral Radiometer	20	0.4-0.7 μm	±17.1°	0.115°
Laser Altimeter	Under Develop	Altimeter	Active Optical	1	TBD	100°	6 x 10
High Resolution Ozone Mapper (HROM)	Under Develop	Map Vertical & Horizontal Atm. Ozone Profiles	Spectral Photometer	TBD	.012-0.4 μm	120° x 3°	TBD

ps	Spectral Bands #	Location	Total Angular Coverage (Deg)	Instantaneous Angular Field of View (Deg)	Look Angle Limitations (Deg)	Size (CM)	(CM)	(CM)	Shape	# of Flight	Weight (KG)	Cooling Requirements Cryogenic
re ning l ster	9	4.5 to 70 μm	6° Across Horizon 40° Azimuth	2° x 1.5°	Horizon Viewing	37	25	42	Rect	2	25	200° K
l eter	3	0.37 to 1 μm	Solar Occultation	0.016°	Solar View at Horizon	15 20	15 15	10 8	Rect Rect	2	7	None
l ter	6	.012-0.4 μm	90° 105°	3° x 3° 11° x 11°	Nadir Viewing Solar View with Diffuser Plate	57 33	38 15	21 20			16.9 7.7	None
ter	10	6.1-17.5 μm	46°, -5° Elev, +45° Azimuth	.014° x .286° .028° x .143° .057° x .143°	Horizon Viewing	37 35	37 35	15 67	Cyl Cyl 3/0, 2/0 (Nimbus Modules)	4	77	65° K
ion ometer	5 5	2-2.4 μm 4-9 μm	7° or 2°	7° or 2°	No Sun View Nadir Viewing	60 18 50	35 18 50	38 36 20	Rect Cyl Rect	1 1	50	LN_2
ter	6	0.31-0.70 μm	2°	0.023°	No Sun View Horizon View 30° From Sun	25	15	15	Cyl	1	4.5	None
ter	6	3950-7000°A	10°	1°	Nadir View	46 31	46 25	38	Rect Rect	1 1	36 25	
ve ter	11	0.61-118.7 GHz	60° Cross-Track 17° Along-Track	.09° - 17.0° Function of Frequency	Nadir Viewing	400	300	250	Rect	1	952	None
aging ve	2	9.0 GHz 1.04 GHz	±5°		20° Off Nadir	1000	310		Rect	1	1248	None
aging re	2	9.3-9.5 GHz 1.7 GHz	10° x 1.2°	0.6° x 3.3° 1.5° x 16.2°	23° Off Nadir	600 150	75 75	30 30		1 1	79 97	None
Spectral er	20	0.4-0.7 μm	±17.1°	0.115°	Nadir Viewing	48	18	17	Rect	1	3.7	
ptical	1	TBD	100°	6×10^{-4}°		1.4m³	-	-			340	None
ter	TBD	.012-0.4 μm	120° x 3°	TBD	Earth Viewing	60	25	25			15	

ular	Look Angle Limitations (Deg)	Size (CM)	(CM)	(CM)	Shape	# of Pkgs	Weight (Kg)	Cooling Requirements Cryogene	Power Requirements Volt	Avg. Pwr. (Watts)	Peak Pwr. (Watts)	Stabili Slew and Settling Time (Deg, Sec)	
	Horizon Viewing	37	25	42	Rect	2	25	200° K		24			
	Solar View at Horizon	15 20	15 15	10 8	Rect Rect	2	7	None		8	15		
	Nadir Viewing Solar View with Diffuser Plate	53 33	38 15	21 20			10.0 7.7	None		20			
	Horizon Viewing	37 35	37 35	15 67	Cyl Cyl 3/0, 2/0 (Nimbus Modules)	4	77	65° K		50	80		
	No Sun View Nadir Viewing	60 18 50	35 18 50	38 36 20	Rect } Cyl } Rect	1 1	50	LN_2	28 VDC	180	185		
	No Sun View Horizon View 30° From Sun	25	15	15	Cyl	1	4.3	None			3		
	Nadir View	46 31	46 25	31 38	Rect Rect	1 1	36 25			400			
	Nadir Viewing	400	300	250	Rect	1	952	None		930			
	20° Off Nadir	1000	310		Rect	1	1248	None		6500			
	23° Off Nadir	800 150	75 75	30 30		1 1	79 97	None		10W for 90 Min. 1075W for 10 Min.			
	Nadir Viewing	48	18	17	Rect	1	5.7		28 VDC	6			
		1.4m^3	-	-			340	None		560	870		
	Earth Viewing	60	25	25			15			15			

Stabilization Requirements				Data						Special Considerations
Settling ne	Rate Stability	Ptg. Accuracy	Stab. Amp	Type of Output	Rate	Format	Storage	Accuracy	Frame Rate	
Sec)	(Deg/Sec)	(Deg)	(Sec)		(Bps)		(Bits)	(Bits/Wd)	(Fr/Sec)	
				Digital	200	NIMBUS 10 Bit Word		10		128 Bit Command Word to Program Scan Pattern
				Digital	2					
		0.3	100	Digital	300 350				1/16 sec	
		0.01	5	Digital	$4x$ 10^3	NIMBUS VIP			8	
		0.1	36	Digital	2016			12	1	
				Serial Digital	$48x$ 10^3					
		0.05	36		$3x$ 10^6					
		0.1	6		$480x$ 10^6					
		±0.5		Digital 5 Bit	$125x$ 10^6	2 Channel				High Resolution Spatial Data After Processing
		0.5	43		TBD					
					$30x$ 10^3					
		0.3	100		2200			TBD		

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage (Deg)	Instantaneous Angular Field of View (Deg)	
				#	Location			
High Speed Interferometer (HSI)	Under Develop	Measure Concent of all Molecular Species with Transition in 2-6 μm	Michelson Interferometer	NA	2-6 μm	1.25°	1.25°	Sol (F or Vie
Cloud Physics Radiometer (CPR)	AAFE	Measure Cloud Height, Cloud Temp, Ice Crystalls and H_2O Droplets	Scanning Imaging Radiometer	5 1	.75-1.65 μm 11.5 μm	90°		NA Vie
Cloud Lidar System (CLS)	AAFE	Measure Cloud Height and H_2O Droplet Phase in Cloud	Active Optical	1	0.6 μm	NA	TBD	NA Vie
Magnetometer	Under Develop	Measure Earth's Magnetic Field in Orbit		NA	NA	TBD		Ear Vie
Microwave Wind Scatterometer (MWWS)	SEASAT	Measure Oceanic Surface Winds (Speed & Direction)	Active Microwave	1	14.6 GHz	25° x 0.5°	2.5-5.0°	±46 NA
Electromagnetic Environment Experiment (EEE)	Under Develop	Measure and Characterize EM Environment Interference	Passive Microwave		.4 - 40 GHz	1° - 5°	1° - 70° Depends on Antennas used.	±70 NA
Adaptive Multibeam Phased Array (AMPA)	Under Develop	Demonstrate Low Power, Point-to-Point Communication, Soil Moisture (Passive)	Active/ Passive Microwave	3	1.5/1.6 GHz (Active) 1.4 GHz (Passive) 12 GHz (Active)	±40°	5°	Hor Hor
Pulsed Compression Radar Altimeter (PCRA)	SEASAT	Measure Attitude Above Ocean Surface to 10 cm. Resolution	Active Microwave	1	13.9 GHz	1.5°	2 mr	NA Vie
Microwave Antenna	Under Develop					1.3°		Hor Hor
Atmospheric X-Ray Emission (AXEE)	Under Develop	Measure Energy & Dist. Bremsstrah Lung X-Rays in Upper Atmos.		NA	1-100 Kev X-Ray	90° x360°		Hor Hor
Bandwidth Compression Modulation (BCM)	Under Develop	Measure Statistical and Operational Perf. Char. of Commun. Links		3	S, X, and K Bands	1° Beamwidth	1°	Ear Vie
Electric Satellite Pyrheliometer (ESP)	AAFE	Measure Solar Constant and Monitor Variation of Solar Rad. in Spectral Bands	Spectral Radiometer	3	0.2 - 50 μm	1.6°	1.6°	Sola Poi
Spaceborne Laser Ranging System (SLRS)	Under Develop	Provide Precise Orbit/Geodetic Baseline Determination	Active Optical			0.03°		±65° Off

Look Angle Limitations	Size			Shape	# of Pkgs	Weight	Cooling Requirements Cryogene	Power Requirements			Stabilization Requirements			
								Volt	Avg. Pwr.	Peak Pwr.	Slew. and Settling Time	Rate Stability	Accuracy	
(Deg)	(CM)	(CM)	(CM)			(Kg)			(Watts)	(Watts)	(Deg. Sec)	(Deg/Sec)	(Deg)	
lar View Horizon NADIR lewing	40	40	20	Rect	2	23							.06	
ADIR lewing	81	25	36			187			25				0.2	
ADIR lewing	76 127	51 97	26 97			205 TBD			1000				0.005	0.4
arth lewing	60 9 45	60 9 45	60 9 45			9.5 10 21	None		10 9 22				0.005	10
16° from ADIR	(4 ea) 300 100	17 41	15 35	Rect	5	55 80			TBD				0.05	18
70° from ADIR	300	300	50			258	None		674				0.1	180
orizon-to-orizon	300 400 400	300 400 400	50 50 50	Rect	3	1500 100 100	None		500 300 600 800				0.3	180
ADIR ewing	1m Dish 64	25	32	Rect	2	70	None		125				0.5	125
orizon-to orizon	$1.3m^3$ $1.0m^3$	- -	- -			110 220		28 VDC, 115 V, 60 Hz	350 250				0.05	90
orizon-to orizon	44	44	35			192			10.2				0.2	360
arth ewing	$1m^2$ Parab. Dish $1.2m^3$	- -	- -			7 233	None	400 Hz	1300				1.2	
lar inting	25.5 14.3	28 34.3	15 9.0			13.5			3.5	22			2.0	
35° F NADIR	82 $1m^3$ Elect.	57	36			60 200			250				0.01	

5a

Stabilization Requirements				Data						Special Considerations
Slew. and Settling Time	Rate Stability	Ptg. Accuracy	Stab. Amp	Type of Output	Rate	Format	Storage	Accuracy	Frame Rate	
(Deg, Sec)	(Deg/Sec)	(Deg)	(Sec)		(Bps)		(Bits)	(Bits/Wd)	(Fr/Sec)	
		.06	20	PCM	50 x 10^3					
		0.2	140		5 x 10^6					
		0.005	0.4		10^3					
		0.005	10		450					Boom Deployed; 10-30 Length Magnetometer Orientation must be known to 20 Sec.
		0.05	18		TBD					
		0.1	180		83 x 10^3 - 2.5 x 10^6					
		0.3	180		2 x 10^6					
		0.5	125		3 x 10^3					
		0.05	90		TBD					
		0.2	360		2 x 10^4					
		1.2			5 x 10^3					Pressurized Module Inside Spacelab Module.
		2.0			320					
		0.01			5 x 10^4					Tracking Accuracy 0.2 mrad for 10 Sec.

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage	Instantaneous Angular Field of View
				#	Location	(Deg.)	(Deg.)
Microwave Directional Wave Spectrometer (MWDWS)	Under Develop.	Ocean Wave Directional Spectral	Real Aperture (Non-Imaging) Microwave	1	X Band or Ku Band	Conical Scan about NADIR 20° NADIR Angle (Cycle to 0° NADIR Angle)	0.5° x 1.0°
Scanning Multichannel Microwave Rad. (SMMR)	NIMBUS G	Ocean Surface Temp, Ocean Currents, Air/Surface Heat Exchange	Dicke Type Radiometer	1	3 or 5 GHz	±35° Cross Track 43° to 55° Fwd Pitch	1° to 2.5°
Active Optical Scatterometer	Under Develop.	Determine Temporal & Spatial Distr. of Aerosols & Cloud Height	Selective Spectral Scatterometer	1	.35 - 1.5 μm	NA	1.8 mrad
Differential Absorption Tuneable Laser	Under Develop.	Measure Conc. Profile of O_3, SO_2, NO_2, Cl_2, Br_2, ClO, ClO_2, HNO_3	Active Optical	2	9.0 -10.5 μm	NA	TBD
Visual & IR Radiometer (VIRR)	SEASAT	Visual & IR Imagery; Surf. Temp. of Ground, Sea & Cloud Tops	Scanning Imaging Radiometer	2	.52 - .73 μm 10.5 - 12.5 μm	140° Cross-Track 1/3° Along-Track	5.3 mrad
Photo Polarimeter	Under Develop.	Measures Polarized Components of Visible Light	Photometer	3	.4 - 1.0 μm	120° Cross-Track 1° Along-Track	1° x 1°
Wave Motion Sensor (WMS)	Under Develop.					3°	
Halogen Occultation Experiment (Haloe)	Under Develop.	Stratospheric Profiles of HCl, HF, CH_4, H_2O	Extinction Photometer			Solar Occultation	
Stratospheric Aerosol & Gas Experiment (SER/SAGE)	Under Develop.	Stratospheric Profiles of O_3, NO_x, Aerosols	Extinction Photometer	4	.38-1.0 μm	Solar Occultation	.016°

Look Angle Limitations (Deg.)	Size (CM)	(CM)	(CM)	Shape	# Of Packages	Weight (KG)	Cooling Requirements Cryogene	Power Requirements Volt.	Avg. Pwr. (Watts)	Peak Pwr. (Watts)	Stabilization Requirements Slew and Settling Time (Deg./Sec.)	Rate Stability (Deg./Sec.)	Ptg. Accuracy (Deg.)
NADIR View					2 Antennas Plus Electronics	100		28 VDC	<250	<400			
NADIR View					2 Scanning Antennas Plus Electronics	30	None	28 VDC	50				1° (Control) .1° (Knowledge)
	.4 m^3					220	None		270				
	1-2 m^3				2-Transmitter & Receiver	TBD			TBD				
NADIR Viewing	21	16	24	Rect.	1	10	None		TBD				±1°
NADIR Viewing	50	35	35	Rect.	1	27.2	None		20	45			
NADIR Viewing	1 m. Parab. Dish 6-0.5 m. Dishes .2 m^3 electronics					91			90				0.5
Solar View at Horizon						20			20	50			
Solar View at Horizon						20			17	50			

Stabilization Requirements				Data						Special Considerations
Slew and Settling Time (Deg./Sec.)	Rate Stability (Deg./Sec.)	Ptg. Accuracy (Deg.)	Stab. Amp (Sec.)	Type of Output	Rate (Bps)	Format	Storage (Bits)	Accuracy (Bits/Wd)	Frame Rate (Fr/Sec)	
				Digital	5×10^6	PCM Serial		7 Bit A/D		2 versions of sensor: (1) Short Pulse Radar Wide Band Rcvr & Spectrum Analyzer (GSFC), (2) Narrow Band 2 freq. Syst (Larc)
		1° (Control) .1° (Knowledge)		Digital (Science) Hskpng	1.5×10^3 2×10^3	PCM Serial		10 Bit A/D Conv.		
				Digital	80×10^6					
					TBD					
		±1°			TBD				2 Lines/sec	
					TBD					
		0.5			10^3					Antennas on 12m Boom Along Flight Vector
				Digital	4×10^3					
				Digital	4×10^3					

Generic Name	Status	Objective	Type	Spectral Bands		Total Angular Coverage	Instantaneous Angular Field of View
				#	Location	(Deg)	(Deg)
Pyrohelliometer	Amps	Measure Total Solar Flux	Radiometer	1	.2-50 μm	5°	5°
Spectrophotometer	Amps	Measure Solar Spectral Distribution	Spectrometer	N/A	.25-4 μm	1°	1°
Grazing Incidence Spectrograph	Amps	Spectral Line Profile	Spectrometer	N/A	300-600° A	N/A	35 min.
Normal Incidence Sptectrograph	Amps	Spectral Line Profile	Spectrometer	N/A	580-1220° A	N/A	20 sec
Echelle Spectrograph	Amps	Spectral Line Profile	Spectrometer	N/A	1150-1800° A	N/A	7 x 32 min.
Grazing Incidence Monochrometer	Amps	Solar Spectrum	Spectrometer	N/A	180-1800° A	N/A	7 x 32 min.
XUV Normal Incidence Spectrometer	Amps AP 102	Identify Constit. & Energy of Ionosphere	Grating Spectrometer	1	300-1300° A	N/A	10° Dia.
UV-VIS-NIR Scanning Spectrometer	Amps AP 103	Identify Neutral Constit. Distribution	Ebert-Fastie Spectrometer	1	1150° A-1.1 μm	N/A	0.8 x 1.8 mrad
Hi-Resolution Fourier SWIR Spectrometer	Amps AP104	Identify Constituents & Distribution of Ions & OH, O_3, NO	IR Interferometer	N/A	1-5 μm	N/A	3 min-5°
Cryogenic Fourier Spectrometer	Amps AP 105	Identify Constitu-ents & Distribution of Ions	IR Interferometer	N/A	5-15 μm	N/A	3-30 min
IR Radiometer	Amps AP 106	Thermal Balance IR O_2 Emission	IR Radiometer	1	15-150 μm	N/A	10° Dia.
Fabrey-Perot Interferometer	Amps AP 107	Velocity & Temp. of Upper Atm. Species	Visible Interferometer	N/A	2500-7000° A	N/A	TBD
Narrow Band Filter Photometer	Amps AP 108	Neutral Density Aerosols, O_3, O_2, Day & Night Airglow	Visible Radiometer	4	1050-8000° A	N/A	1 min-1 deg

ar	Look Angle Limitations	Size			Shape	# of Pkgs	Weight	Cooling Requirements	Power Requirements			Stabilization Requirements		
								Cryogens	Volt	Avg. Pwr	Peak Pwr.	Slew and Settling Time	Rate Stability	Pkg. Accuracy
	(Deg)	(CM)	(CM)	(CM)			(KG)			(Watts)	(Watts)	(Deg, Sec)	(Deg/Sec)	(Deg)
	Solar Pointing					1		None		10				.5°
	Solar Pointing					1		None		10				.5°
	Solar Pointing	175	61	10	Rect	1	36	None		20				.25°
	Solar Pointing	148	46	31	Rect	1	56	None		20				.1°
	Solar Pointing	87	31	10	Rect		27	None		20				.5°
	Solar Pointing	61	30	30	Cyl	1	14	None		10				.25°
	Earth Viewing	24	90	79	Rect	1	11.4		110 VAC 40 CY	TBD	30			.05°
	Earth Viewing	55	37	130	Rect	1	106		110 VAC 40 CY	TBD	25			
	Earth Viewing	52	70	30	Rect	1	54		110 VAC 40 CY	TBD	25			
	Earth Viewing	90	90	75	Rect	1	134		110 VAC 40 CY	TBD	25			
	Earth Viewing	30	30	90	Cyl	1	24.8		110 VAC 40 CY	TBD	20			
	Earth Viewing	30	30	90	Cyl	1	22.8		110 VAC 40 CY	TBD	20			
	Earth Viewing	25	25	75	Cyl	4	18.4		110 VAC 40 CY	TBD	20			

7a

Stabilization Requirements				Data						Special Considerations
and Settling Time	Rate Stability	Ptg. Accuracy	Stab. Amp.	Type of Output	Rate	Format	Storage	Accuracy	Frame Rate	
g. Sec)	(Deg/Sec)	(Deg)	(Sec)		(Bps)		(Bits)	(Bits/Wd)	(FR/Sec)	
		.5°			10^3					
		.5°			10^3					
		.25°			$10x10^3$					
		.1°			$10x10^3$					
		.5°			$10x10^3$					
		.25°			10^3					
		.05°			$5x10^3$					
					320					
					TBD					
					TBD					
					10^4					
					TBD					
					10^3					

ADDITIONAL EARTH OBSERVATION SENSORS

SENSOR	PROGRAM/IDENTIFIER	MAJOR FUNCTION
SPACECRAFT		
Scanning Radiometer (SR)	ITOS-7	Cloud Monitoring, Surface Temperature
Vertical Temperature Profile Radiometer (VTPR)	ITOS-7	Temperature Sounding
Very High Resolution Radiometer (VHRR-ITOS)	ITOS-7	Cloud Monitoring, Surface Temperature
Visible IR Spin Scan Radiometer (VISSR)	SMS-1	Cloud Monitoring, Surface Temperature
TIROS Operational Vertical Sounder (TOVS)	TIROS-N	
- Basic Sounding Unit (BSU)		Temperature & H_2O Sounding
- Stratospheric Sounding Unit (SSU)		Temperature Sounding
- Microwave Sounding Unit (MSU)		Temperature Sounding
Large Earth Survey Telescope (LEST)	SEOS A	Earth Resources Survey, Atmospheric Sounding
Very High Resolution Radiometer Experiment (VHRR-ATS)	ATS 6	Cloud Monitoring, Surface Temperature
Heat Capacity Mapping Radiometer (HCMR)	AEM-A	Surface Temperature
Stratospheric Aerosol and Gas Experiment (SAGE)	AEM-B	Aerosol Properties
Modified VISSR (VAS)	OSIP	Cloud Monitoring, Atmospheric Sounding
TIROS 5-Channel Radiometer (TVCR)	TIROS	Cloud Monitoring, Surface Temperature
AIRCRAFT		
Modular Multiband Scanner (M^2S)	A/C	Earth Resources Survey
Passive Microwave Imaging System (PMIS)	A/C	Earth Resources Survey
Scanning Imaging Spectroradiometer (SIS)	A/C	Earth Resources Survey
Thermal Scanner (RS-18)	A/C	Surface Temperature
24 Channel Multispectral Scanner (MSDS)	A/C	Earth Resources Survey, Multispectral Research
AAFE		
Radiometer/Scatterometer (RADSCAT)	FY70	Sea State
S-Band Microwave Radiometer	FY70	Sea Surface Temperature
CO Pollution Experiment (COPE)	FY70	Pollution Monitoring-Total Burden

SENSOR	PROGRAM/IDENTIFIER	MAJOR FUNCTION
Microwave Temperature Sounder (MTS)	FY71	Temperature Sounding
High Speed Interferometer (HSI)	FY71	Pollution Monitoring-Total Burden
IR Heterodyne Radiometer (IHR)	FY74	Pollution Monitoring-Sounding
Multispectral Active/Passive Microwave System	FY74	Sea State, Water Content Measurement
Surface Profile Radar (SPR)	FY74	Sea State
Coherent Imaging Radar (CIR)	FY74	Costal Zone Processes
Long Term Zonal Earth Energy Budget (LZEEBE)	FY74	Earth Radiation Budget
Advanced Atmospheric Sounder & Imaging Radiometer (AASIR)	FY74	Severe Storm Monitoring, Temperature Sounding
High Spectral Resolution Laser Radar	FY75	Aerosol Properties, Cloud Physics
Airborne Oceanographic Lidar	FY75	Turbidity, Water Pollution Monitoring
Active/Passive Multispectral Scanner	FY75	Earth Resources Survey
Microwave Limb Sounder (MLS)	FY75	Temperature & Pollution Sounding
Laser Absorption Spectrometer (LAS)	FY75	Pollution Monitoring-Sounding
SUPPORTING RESEARCH & TECHNOLOGY PROGRAM		
Cloud Top Scanner (CTP)	175-21-48-01	Cloud Physics
Ocean Temperature Sensor (OTS)	175-21-41-07	Surface Temperature
IR EBERT Spectrometer	175-21-41-04	IR Spectrum Research
IR Heterodyne Sounder	175-21-41-06	Temperature & H_2O Sounding
Multiple Level Ozone Field Mapper (MLOFM)	175-21-42-02	Ozone Sounding
L-Band Radiometer	175-31-31-02	Ocean Salinity
Sweep Frequency Radiometer	175-31-31-02	Sea State, Soil Moisture
Gas Filter Correlation Analyzer (GFCA)	176-21-31-02	Pollution Monitoring-Total Burden
Correlation Radiometer For Tropospheric Pollution (CRTP)	176-21-41-01	Pollution Monitoring-Total Burden

SENSOR	PROGRAM/IDENTIFIER	MAJOR FUNCTION
Ocean Color Sensor (OCS)	177-22-41-04	Ocean Color
Heat Capacity Mapper (MCM)	177-51-41-01	Surface Temperature
Short Pulse Wind/Wave Sensor	369-03-06-03	Wind Speed, Wave Spectra
Airborne Oceanographic Probing Experiment (AOPE)	502-23-56	Pollution Monitoring
SHUTTLE		
Orbiting Meteorological Radar	645-10-02	Wind Speed, Water Content Measurements
IR LIDAR	645-20-01	Aerosol, O_3 & H_2O Sounding
MK II Interferometer	645-20-02	Pollution Monitoring, Total Burden
Modular Scanning Spectromradiometer	645-30-06	Earth Resources Survey
High Resolution Imaging Radar	645-30-07	Earth Resources Survey
Low Noise Microwave Radiometer	645-50-05	Surface Temperature Water Content Measurements